

RECOMMENDATION 650-2*

**STANDARDS FOR CONVENTIONAL TELEVISION SYSTEMS
FOR SATELLITE BROADCASTING IN THE CHANNELS DEFINED
BY APPENDIX 30 OF THE RADIO REGULATIONS**

(Questions 84/11 and 95/11)

(1986-1990-1992)

The CCIR,

considering

- a) that the introduction of the broadcasting-satellite service offers the possibility of reducing the disparity between television standards throughout the world;
- b) that this introduction also provides an opportunity, through technological developments, for improving the quality and increasing the quantity and diversity of the services offered to the public; additionally, it is possible to take advantage of new technology to introduce time-division multiplex systems in which the high degree of commonality can lead to economic multi-standard receivers;
- c) that it will no doubt be necessary to retain 625-line and 525-line television systems;
- d) that broadcasting-satellite services are being introduced using analogue composite coding according to Annex 1 of Recommendation 470 for the vision signal;
- e) that it is generally intended that broadcasting-satellite standards should facilitate the maximum utilization of existing terrestrial equipment, especially that which concerns individual and community reception media (receivers, cable, re-broadcasting methods of distribution etc.). For this purpose a unique baseband signal which is common to the satellite-broadcasting system and the terrestrial distribution network is desirable;
- f) that the requirements as regards sensitivity to interference of the systems that can be used were defined by Appendix 30 of the Radio Regulations (RR);
- g) that complete compatibility with existing receivers is in any event not possible for frequency-modulated satellite broadcasting transmissions;
- h) that, as far as the video signal is concerned:
 - the basis for the transmission of separate components has been established as an important principle by the CCIR in Recommendation 601;
 - studios using component vision signals will produce pictures of higher quality than present-day studios using composite signals;
 - the picture quality with present composite standards is limited by cross luminance/chrominance effects resulting from the band-sharing of luminance and chrominance signals;
 - new technologies are available for receiver design which permits a new approach using separate colour components that are time-compressed and transmitted in time-division multiplex;
 - a separate component approach allows scope for future enhancements of picture quality;
- j) that as far as the sound channels and the data services accompanying the television picture are concerned:
 - according to § m) of Decision 51-2, technical developments permit the use of digital techniques to be envisaged;
 - the use of digital coding permits a large improvement in sound quality to be obtained;

* *Note from the Director, CCIR* – The following Reports of the CCIR were considered in relation with this Recommendation: 624-4, 632-4, 795-3, 802-3, 953-2, 954-2, 1073-1, 1074-1 and 1228.

- it is important to select for adoption, from the systems described in Report 632*, that which offers the greatest possible capacity whilst making the best possible use of the radio-frequency channels defined by Appendix 30 of the RR, taking into account, if necessary, § e) above;
 - the principle of time multiplexing of sound and digital data, on the one hand, and the picture signal, on the other hand, eliminates the problems of intermodulation between the signals;
- k) that as far as the multiplexing of the audio signals and the data signals corresponding to the television auxiliary services defined in Appendix 2 to Annex 1 is concerned:
- it is important to make the best possible use of the capacity offered by the digital modulation system;
 - it is desirable to use the coding standards for digital audio channels specified in Recommendation 651 and the CCIR special publication "Specifications of Transmission Systems for the Broadcasting-Satellite Service" and to be able to associate with this baseband coding several layers of error protection, in order that it may be adapted to suit the particular requirements of the administrations;
 - it is important to ensure maximum flexibility in the multiplexing process, which is to be selected from those whose principles are described in Appendix 2 to Annex 1, in order that the particular requirements of the administrations may be met for the sharing of the available capacity between audio services and data services, to permit this sharing to be modified in time, and to allow the later introduction of new services that are not yet identified;
- l) that the ruggedness of the system should be such as to provide a service down to the lowest possible carrier-to-noise ratio,

recommends

that when a broadcasting-satellite service is introduced in the 12 GHz band channels defined by Appendix 30 of the RR, the preferred systems for television services using 625-line and 525-line standards (Note 1) should be:

- the systems using multiplex analogue components according to Annex 1 (Note 2);
- the systems using analogue composite coding for the vision signal as described in Annex 1 or according to Recommendation 470 or for certain administrations in Region 2, variations thereof.

Note 1 – The issue of the transmission signal format for the broadcasting-satellite service is still under consideration in both Canada and the United States of America. Two types, a component television system (B-MAC 525-line as described in Annex 1, § 2.2) and several composite television systems based on the NTSC baseband vision signal format, are included in these considerations.

Note 2 – For a number of administrations in Region 1 (those administrations of countries which have active members of the EBU) one member of the MAC/packet family (i.e. C, D, D2) should be used.

ANNEX 1

Television standards for the broadcasting-satellite service

1. Introduction

This Annex briefly describes in a comparative manner the basic characteristics of some of the systems which have been developed for television transmission with sound and data services for satellite broadcasting. Recognizing that there are advantages in reducing the number of modulation methods and the differences in the characteristics of these modulation methods, the basic parameters of each system were used to produce tables which stress the

* A Handbook is being prepared that contains descriptions of the essential modulation methods presently contained in Report 632-4.

similarities between systems. Only fully specified systems adopted, or being seriously considered for adoption, by at least one administration, were considered in these tables. The detailed specifications of these systems are contained in a separate CCIR publication "Specifications of Transmission Systems for the Broadcasting-Satellite Service".

Special considerations should be given to those systems that have adopted the general principle of time-division multiplexing since it permits an improvement in the quality of the signals by eliminating, in particular, the problems of intermodulation and cross-colour. A time-division multiplex structure also permits subsequent compatible introduction of further services or further improvements to the quality of the basic services. For example, wide-screen aspect ratio pictures can be transmitted. Displays of the 4:3 type can present the most interesting portion of the picture, selectable by a digital data signal. Further details are given concerning these improvements to the vision signal in Appendix 1.

All systems described in this Annex apply digital techniques for the sound (and for the data) in order to utilize to the greatest possible extent the capacity made available by the channels defined by Appendix 30 of the RR, taking into account if necessary the need for direct translation on distribution networks with narrower bandwidths. The use of a sound/data multiplex (associated with the service-identification system) making available the capacity required, and at the same time the maximum flexibility, is also a very important asset. Possibilities of scrambling the signal for secure transmission and controlled reception are increasingly viewed as an important feature of such systems.

This Annex presents a short summary of the main features of each of the fully specified systems considered. It is followed by tables listing values for the main characteristics of each system.

2. Summary description of the systems

2.1 MAC/packet family

The MAC/packet family of standards has three members all suited to satellite broadcasting: C-MAC/packet, D-MAC/packet and D2-MAC/packet. These systems have been optimized under different constraints and meet the various broadcasting-satellite service requirements in the 12 GHz band when the 625-line standard is used with a satellite channel of 27 MHz bandwidth.

The systems incorporate the following common features:

- time division multiplexing;
- MAC picture coding, with the capacity for extended aspect ratio;
- packet multiplexing for sound and data;
- digital high and medium quality sound coding and error protection method (see Recommendation 651 and the CCIR special publication "Specifications of Transmission Systems for the Broadcasting-Satellite Service");
- service identification and conditional access systems with video and audio scrambling system specifications issued by several organizations;
- full channel digital mode, when the area of the television frame normally reserved for the MAC vision signal (and its blanking interval) is replaced by data burst (see Recommendation 712).

The clock frequencies used in these three systems have simple relationships with the sampling frequencies of the digital studio standard defined in Recommendation 601.

This close relationship between these systems allows for the development and introduction of receivers capable of functioning with all of the standards.

2.1.1 C-MAC/packet

The C-MAC/packet system was, in part, developed to provide a high data channel capacity.

The particular features of the C-MAC/packet system are:

- the use of an RF time division multiplex wherein the carrier is frequency modulated by analogue picture signals during a certain fraction of line duration and 2-4-PSK modulated during the remainder of the line duration by a multiplex conveying several sound channels, synchronization and data signals;
- the capacity of the sound/data multiplex is about 3 Mbit/s, equivalent to eight high quality sound channels of 15 kHz bandwidth with near instantaneous 14/10 bit companding (protected by one parity bit per sample). The spare data capacity can be used for other services.

2.1.2 D-MAC packet

The D-MAC/packet system was, in part, developed to provide both a high data channel capacity and a single baseband interface to other transmission and distribution media.

The particular features of the D-MAC/packet system are:

- a baseband time division multiplex in which the analogue picture signals are combined with duobinary encoded digital sound, synchronization and data signals;
- the capacity of the sound/data multiplex is about 3 Mbit/s, equivalent to eight high quality sound channels of 15 kHz bandwidth with near instantaneous 14/10 bit companding (protected by one parity bit per sample). The spare data capacity can be used for other services;
- the single baseband representation of the time division multiplex signal is frequency modulated for satellite broadcasting.

The D-MAC/packet system has been under further investigation by experts of a number of organizations and has also been shown to be suitable for satellite broadcasting.

As a result of these developments, the United Kingdom and Norway now use the D-MAC/packet system for their 12 GHz band broadcasting-satellite services.

2.1.3 D2-MAC/packet

The D2-MAC/packet system was, in part, developed to provide a single baseband interface to other transmission and distribution media.

The particular features of the D2-MAC/packet system are:

- a baseband time division multiplex in which the analogue picture signals are combined with duobinary encoded digital sound, synchronization and data signals;
- the capacity of the sound/data multiplex is about 1.5 Mbit/s, equivalent to four high quality 15 kHz sound channels with near instantaneous 14/10 bit companding (protected by one parity bit per sample). The spare data capacity can be used for other services;
- the single baseband representation of the time division multiplex signal is frequency modulated for satellite broadcasting.

The Federal Republic of Germany and France have adopted the D2-MAC/packet system for operational use of their 12 GHz band broadcasting-satellite services (TV-SAT2 and TDF-1 and TDF-2).

2.2 *B-MAC systems*

Two closely related implementations of the B-MAC system have been developed for 525 and 625 line applications. Both systems are well suited to use in broadcasting-satellite service applications in the 12 GHz band using either 24 MHz or 27 MHz channelling.

The B-MAC signal is a baseband time division multiplex comprising analogue picture signals combined with a four (or two) level data burst containing digital sound, synchronization and data information.

Vision signal coding is performed using the same time compression factors as the C-MAC/packet and D2-MAC/packet systems. The clock frequencies of 625/50 and 525/60 B-MAC systems are the same multiples of the relevant line scan frequencies to permit use of the same integrated circuit devices for both systems. In the 525 line version the clock frequencies are simply related to the NTSC sub-carrier frequency, facilitating simple transcoding to NTSC. Both B-MAC systems can be configured to permit transmission of pictures with 16:9 aspect ratios.

The B-MAC systems provide a total data capacity of about 1.6 Mbit/s. This can be used to provide six high quality 15 kHz audio channels using adaptive delta modulation which features error concealment and parity protection (see CCIR special publication "Specifications of Transmission Systems for the Broadcasting-Satellite Service"); alternatively these channels may be configured as 204 kbit/s data channels. A utility data channel makes use of spare capacity in the data multiplex.

Included in the B-MAC structure is a conditional access system based on line translational scrambling for video, and data encryption for digital audio. Because of the high degree of commonality between the 625 and 525 line B-MAC systems it will be possible to develop a single receiver capable of receiving either B-MAC system.

The B-MAC system provides a single baseband interface to other transmission and distribution media.

The 625 line B-MAC system has been adopted in Australia for the Homestead and Community Broadcasting-Satellite Service (HACBSS) which commenced operation in October 1985.

The 525 line B-MAC system is under active consideration by the Direct Broadcasting Satellite Association and the Advanced Television Systems Committee in the United States and also by Canada.

2.3 *Digital sub-carrier/NTSC system*

In this system a digital sub-carrier is frequency multiplexed with the conventional NTSC vision signal. It has been developed for use in the broadcasting-satellite service.

The vision parameters of the system are based on those of system M/NTSC described in Recommendation 470, thus the system is compatible with the terrestrial vision standard.

The sound/data signals are carried on a 5.73 MHz sub-carrier using differential 4-PSK. This sub-carrier, together with the vision signal, frequency modulates the main carrier. The data capacity of the system is about 2 Mbit/s. This can provide four 15 kHz high quality audio channels using 14/10 bit near instantaneous companding, or two 20 kHz very high quality channels through the use of 16 bit linear coding. An additional data channel is also provided in both cases. Both schemes use BCH (63,56) coding error protection.

This system was adopted by the Japanese Administration in 1982 for use with its operational broadcasting-satellite service. This service commenced operation in May 1984 using BS-2a; it conforms to Appendix 30 of the RR.

Detailed specifications have been defined for the data channel, the capacity of which varies from 224 to 1 760 kbit/s depending on the mode of sound transmission. A packet multiplexing scheme is used for the data channel (see Appendix 2).

TABLE 1
Vision/data multiplex structure

Parameter/System	MAC/packet systems			B-MAC (625 line)	B-MAC (525 line)	Digital sub-carrier/ NTSC
	C	D	D2			
1.1 Modulation frame frequency (Hz)	25					29.97
1.2 Number of lines per picture (frame)	625					525
1.3 Line frequency (Hz)	15 625					15 734
1.4 Number of time increments per line	1 296			1 365		—
1.5 Nominal reference clock frequency (MHz)	20.25			21.328	21.477	—
1.6 Multiplexing principle	Radio frequency	Baseband				Sub-carrier
1.7 Vision coding	Time multiplexed analogue components					Composite (1)
1.8 Nominal transmitted vision bandwidth (MHz)	8.4 (2)			7.5 (2)	6.3 (2)	4.5
1.9 Nominal vision amplitude (V peak-to-peak) (3)	1.000					
1.10 Data coding	See § 4.2 of Table 4	Duobinary		Quaternary/binary (4)		See § 4.2 of Table 4
1.11 Symbol rate (Mbaud)	20.25		10.125	7.11	7.16	2.048
1.12 Occupied data spectrum (MHz)	Not applicable	10.0	5.0	7.11 (5)	7.16 (5)	1.2
1.13 Nominal data amplitude (V peak-to-peak) (3)	Not applicable	0.800	0.800	0.770		See Table 4
1.14 Number of bits per symbol	1			2/1 (4)		1
1.15 Instantaneous bit rate (Mbit/s)	20.25		10.125	14.22/7.11 (4)	14.32/7.16 (4)	2.048
1.16 Multiplex description (6)	Flexible (7)			Rigid		—
1.17 Basic frame multiplex configuration	See Fig. 1					—
1.18 Basic line multiplex configuration	See Fig. 2a)	See Fig. 2b)	See Fig. 3	See Fig. 4		—

